Sampling Frame Model (FRAME) for the Park Units in the Northern Colorado Plateau Network

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Introduction

A critical feature of survey sampling is the delineation of the target population as a finite list of non-overlapping elements. This list of elements is known as a sampling frame, and serves as the basis for selecting sampling sites. The Northern Colorado Plateau Inventory and Monitoring Network (NCPN) uses a grid-based frame for monitoring a suite of vital signs. A grid-based frame is a randomly-oriented grid of points, with points representing the centroid of square grid cells.

The NCPN created a customized model to facilitate evaluation of alternative grid-based sampling frames. The model, called FRAME, is coded in C and runs on standard PC computers. This document describes the basic features of the FRAME model, including input requirements, calculations, and output, and the syntax for running the model.

Data Requirements

FRAME requires a user-supplied minimum bounding box to generate a grid-based sampling frame. The minimum bounding box is simply the smallest rectangle that encompasses the area of a park (Fig. 1A). Only the lower left and upper right UTM coordinates of the minimum bounding box are required.

Overview of Calculations

FRAME randomly determines the orientation of the sampling frame. A user-supplied random number seed (i.e., a negative number) is used to initiate the Ran2 random number generator, which is documented in Press et al. (1988). To simplify calculations, the orientation is bounded by 0-90 degrees. Also, an orientation greater than 90 degrees simply repeats grids with 0-90 degree orientation.

Given a random orientation, FRAME generates a rotated bounding box that covers the minimum bounding box. Deriving the rotated bounding box is a three step process. Given the orientation, partial lengths of the edges of the rotated box are first determined (Fig. 1A – Pn, Ps). This is followed by the derivation of corner coordinates of the rotated box (Fig. 1B). FRAME then locates grid points at the user-specified spacing within the rotated box. The first point to be generated always corresponds to the lower-left corner, which is the anchor point of the sampling frame (n3, e3 in Fig 1B). Point locations are determined starting at the anchor point and moving up and to the right. The ability to locate a point at the calculated top (i.e., n1, e1 in Fig. 1B) of the rotated box is determined by the height (Pn in Fig 1B) and the point spacing. If height is not evenly divisible by the point spacing, then the difference between the bottom and top points will be less than the internally derived height. The same is true with width.

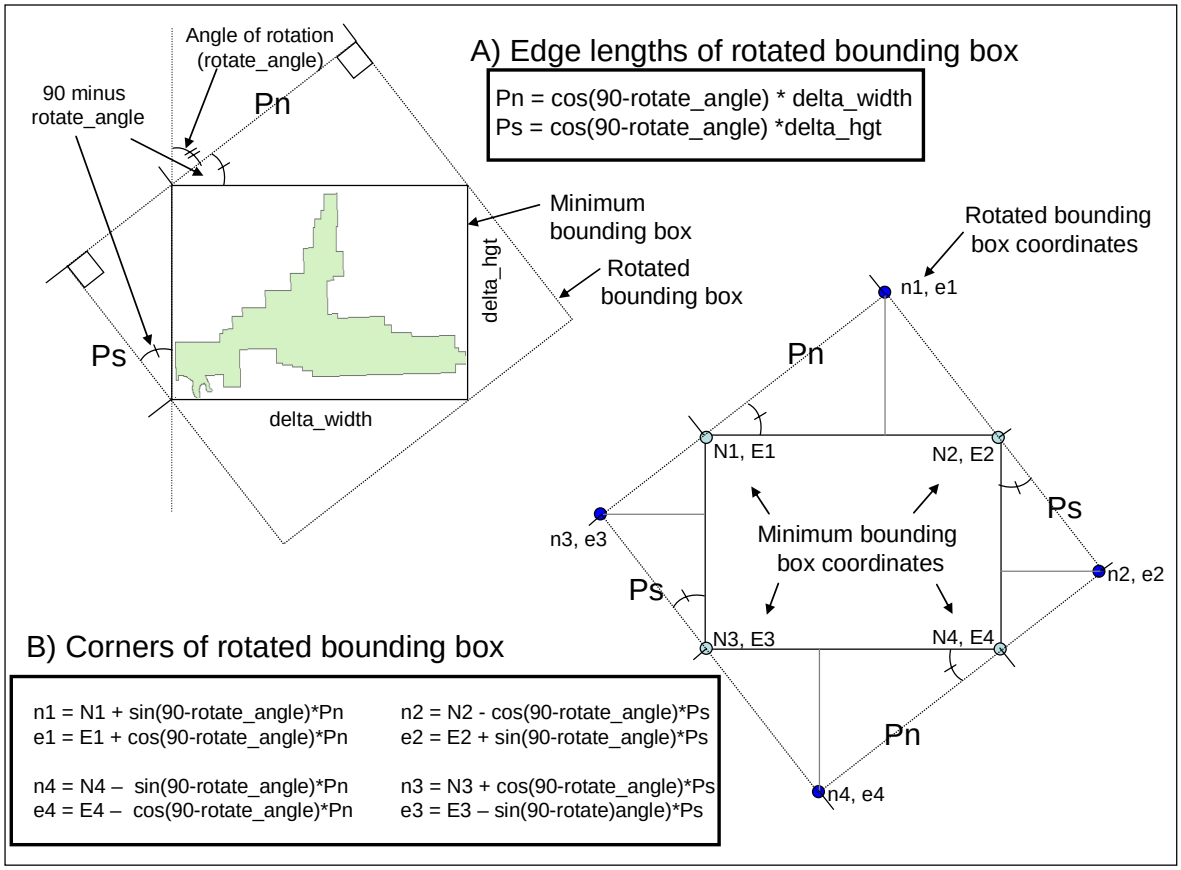

Figure 1. Derivation of corner coordinates of a rotated bounding box given a minimum bounding box for a park.

The output from the program consists of the UTM coordinates of the grid points in ASCII format, and a file containing the selected orientation (degrees) and the corner coordinates of the rotated bounding box. The grid-point coordinates can be imported into ArcGIS for display and further analyses. Since points will extend beyond the park boundary, the generated grid points must be clipped with a park boundary in GIS.

Sampling frames for a park can be generated with different spacing requirements. Given consistency in all other inputs, FRAME will generate the same orientation and the same rotated grid regardless of the specified spacing. Also, a point will always be produced at the anchor point of the rotated box (n3, e3 in Fig. 1B). The extent of the grid, however, will vary with the specified spacing due to the way points are distributed (see above). Regardless of spacing requirements, the park landscape will be completely covered.

Output

Two ASCII-formatted file types are produced by FRAME. One contains UTM coordinates of each derived element in the following order - northing, easting. The user specifies a template file name which is automatically appended with a sequential number starting with 1. Each sequentially numbered file contains a maximum of 65500 elements. For example, given a template file name of ARCHgrid, the file ARCHgrid1 will contain the first 65500 elements, ARCHgrid2 will contain the next 65500 elements, etc. This limitation was imposed to facilitate importing the elements of a frame into ArcMAP as an Excel-created database. The other file records the derived orientation angle (degrees), and the corner UTM coordinates of the rotated bounding box. For the latter, UTMs are recorded as northing followed by easting values.

The user has the option to limit the number of elements written to the output. This sometimes is convenient for large or irregularly-shaped parks because of the large number of elements that tend to fall outside a park boundary. An output bounding box is delineated by specifying the UTM coordinates of the vertical and horizontal extremes. The user is responsible to ensure that the delineated area is sufficient to encompass the extent of a park. Enter zeros for the coordinates of this bounding box defaults to recording the full extent of the calculated grid of elements.

Program Syntax

To operate the FRAME model, you must store the executable as frame.exe. To run FRAME, enter the following:

frame <seed> <pt_interval_m> <UTMNLL> <UTMELL> <UTMNUR>
<UTMEUR> <xy_output> <box_coords_output> <W> <E> <N> <S>

where;

<seed> is a random-number seed (a negative integer),
<pt_interval_m> is the desired grid-point spacing in meters,
<UTMNLL> is the lower-left northing UTM coordinate of the minimum bounding box,
<UTMELL> is the lower-left easting UTM coordinate of the minimum bounding box,
<UTMNUR> is the upper-right northing UTM coordinate of the minimum bounding box,
<UTMEUR> is the upper-right easting UTM coordinate of the minimum bounding box,
<xy_output> is the template file name for storing the resulting UTM coordinates of the frame elements,
<box_coords_output> is the file name for storing the randomly derived rotation angle (degrees), and the UTM coordinates of the corners of the rotated bounding box,

<W>, <E>, <N>, <S> collectively define the bounding box for the output grid, with W and E being the coordinates of the western and eastern bounds, respectively, and N and S being the coordinates of the northern and southern bounds, respectively. These coordinates are in UTM. Entering zeros for all four dimensions default to recording the full extent of the calculated grid of points.

The frame.exe program can reside anywhere on your computer, but an explicit path to the directory containing the program must be inserted via the PATH command or included in the command-line syntax; E.g., h:\samplingframe\frame <> <>…

Literature Cited

Press, W. H., S. A. Teukolsky, W. T. Vetterling, and B. P. Flannery. 1988. Numerical Recipies in C, second edition. Cambridge University Press, Cambridge, UK.

FRAME Revision History

Prev. Version #	Revision Date	Author	Changes Made	Reason for Change	New Version #